Classification of the vegetation of the B land type in the north-western Orange Free State

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An analysis of the vegetation of the B land type, covering 928 000 hectares in the north-western Orange Free State is presented. More than 80% of the area has been ploughed. Relevés were compiled in 104 stratified random-sample plots in the remaining natural vegetation. A TWINSPAN classification, refined by Braun-Blanquet procedures revealed seven plant communities which may be classified under four major communities. All communities are related to specific environmental conditions. Descriptions of the communities are given.

'n Analise van die plantegroei van die B-landtipe, wat 928 000 hektaar van die noord-westelike Oranje-Vrystaat beslaan word aangebied. Meer as 80% van die gebied is geploeg. Relevés is in 105 gestratifiseerde ewekansig-gekose monsterpersele saamgestel in die oorblywende natuurlike veld. 'n TWINSPAN-klassifikasie verfyn deur die Braun-Blanquet-tegnieke toon sewe plantgemeenskappe, wat in vier hoof-gemeenskappe gegroepeer kan word. Die geïdentifiseerde gemeenskappe kan verklaar word aan die hand van spesifieke omgewingsfaktore. Die plantgemeenskappe word beskryf.

Keywords: Braun-Blanquet method, classification, Grassland Biome, plant communities

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Introduction

The necessity to identify and describe the major vegetation types and subtypes within the Grassland Biome was stated by Mentis & Huntley (1982) and Scheepers (1986). One of the goals of the vegetation classification and mapping task group of the comprehensive Grassland Biome programme is to produce a vegetation classification and map on a 1 250 000 scale (Scheepers 1986). A synecological and syntaxonomical investigation was therefore undertaken in the north-western Orange Free State (Figure 1). Land types (Land Type Survey Staff 1984) represented in this area include the A, B and D land types as well as small patches of the Fb and Ib land types. Previous phytosociological analyses in the north-western Orange Free State include those of Scheepers (1975) in the Kroonstad area and Du Preez (1987) in the Vredefort district. Within the present research project Kooij *et al.* (1990b) classified and described the vegetation of the D land type in the study area. Little is known of the vegetation of the B land types of the north-western Orange Free State.

The B land type represents the vast plains of the north-western Orange Free State. Only 3% of this land type is unsuitable for agronomy. More than 80% of the soils of the B land type have been ploughed and the few relics of natural vegetation are often degraded due to grazing or other land-use practices (Land Type Survey Staff 1984). The natural vegetation of this area is clearly endangered by the existing farming practices in the area. The identification, description and classification of existing grassland plant communities of this area should have high priority, not only as a basis for efficient vegetation (grazing) management (Bosch *et al.* 1987), but also to help identify areas suitable for conservation of these ecosystems in the future. The aim of this study was therefore to identify, characterize and describe the plant communities of the B land type in the north-western Orange Free State. The results should contribute considerably to the knowledge of this vegetation type and to a phytosociological synthesis of the western Grassland Biome.

The study area

The study area is situated between 26°00′ and 27°23′ E longitude and 27°00′ and 28°00′ S latitude, in the Grassland Biome of the north-western Orange Free State, South Africa (Figure 1). A detailed description of the physical environment of the area is given by Kooij *et al.* (1990a). The area covered by the B land type in the study area is indicated in Figure 1.

Within the study area the B land type is subdivided into the Bc and Bd types. These two land types accomodate land where duplex and margalitic soils occupy less than 10% of the area and plintic soils overlying sandstone are predominant (Land Type Survey Staff 1984). The Bc and Bd land types cover approximately 928 000 hectares within the study area, of which approximately 25 000 hectares are unsuitable for agriculture. A perfect catena in the B land type is represented by a succession of the Hutton, Bainsvlei, Avalon and Longlands soil forms, while valley bottoms are occupied by gley soils for example the Rensburg Willowbrook or Katspruit soil forms (Land Type Survey Staff 1984). The Bc land type refers to land where eutrophic, red soils are widespread, whereas the Bd land type refers to land where eutrophic, yellow soils are widespread. The soils of the B land type are excellent for agronomy. Extensive areas have consequently been

Figure 1 The location of the Bd and Bc land types in the study area (Land Type Survey Staff 1984). Legend: Land type Bd ⊞; Bc ⊟; other □.

ploughed for the cultivation of maize, peanuts, potatoes and sunflowers.

The geology of the Bc land type consists predominantly of Karoo sediments, consisting of Ecca sandstone, mudstone and shale with calcrete. Dolerite sills are abundant. Aeolian and colluvial sand overlies all rock types which are a conspicious feature of this area. Pans occupy only 1–2% of this area. Soils of the Hutton, Avalon and Bainsvlei forms predominate on the relatively raised plains. In the lowland situations Rensburg, Willowbrook, Katspuit and Sterkspruit soil forms predominate.

As it is the case with the Bc land type, the geology of the Bd land type consists mainly of Ecca sandstone, shale and mudstone. Dolerite sills and diabase plates however occur only sporadically. Aeolian sand overlies most of the rocks. Pans occupy 0.5–2% of this land type (Land Type Survey Staff 1984). Soils of the Avalon, Hutton, Westleigh and Bainsvlei soil forms predominate on the upland sites, while the Willowbrook, Katspruit, Dundee, Bonheim, Valsrivier and Swartland forms are predominant in bottomland situations (Land Type Survey Staff 1984).

Methods

Relevés were compiled in 105 stratified random sample plots. Within each land type, stratification of sampling was based on five terrain units following De Beer (1988) and Land Type Survey Staff (1984) namely (1) crests, (2) scarp, (3) midslope, (4) footslope and (5) valley bottom or flood plain (Figure 2). In accordance with Scheepers (1975), plot size of 16 m^2 (4 × 4 m) was used to survey grassland vegetation, while 100-m^2 (10 × 10 m) plots were used for woody vegetation (Bredenkamp & Theron 1978).

In each sample plot all species recognizable at the time of the survey (summer 1988/1989) were noted. The cover-abundance of each species was estimated using the Braun-Blanquet cover-abundance scale as described by Mueller-Dombois & Ellenberg (1974). Plants were named according to Gibbs-Russell *et al.* (1985, 1987), except for *Setaria flabellata* Stapf. and *S. sphacelata*

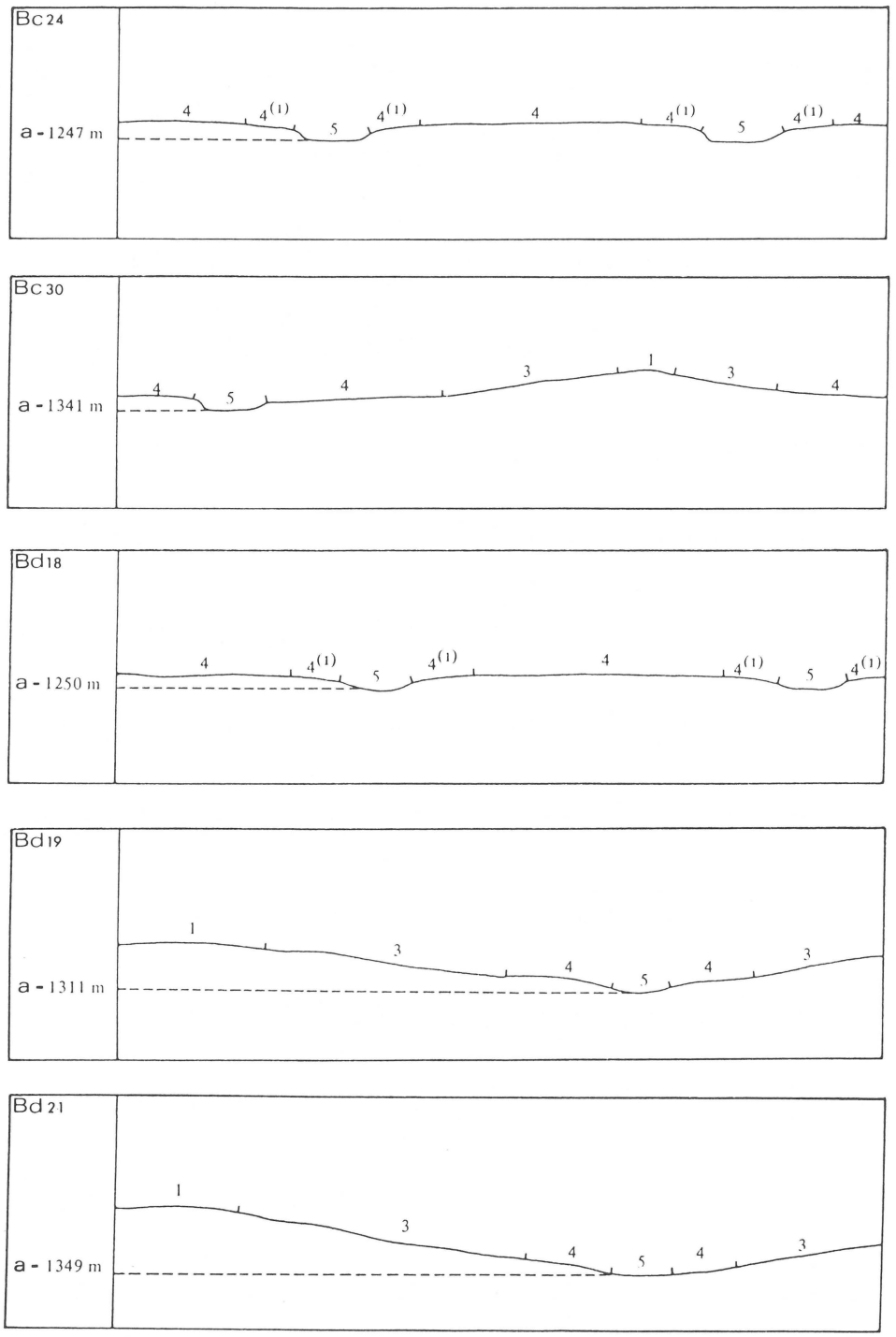


Figure 2 A schematical representation of the different terrain units in the B land type (Land Type Survey Staff 1984). Legend: Terrain unit: 1 — crest; 2 — scarp; 3 — midslope; 4 — footslope; 5 — valley bottom or flood plain; a — altitude.

(Schumach.) Moss which were distinguished as two separate taxa as was done by Bredenkamp *et al.* (1989). Environmental information collected includes terrain type, soil type, aspect, slope and rockiness of the soil surface.

Two-way indicator species analysis (TWINSPAN) (Hill 1979) was applied to the floristic data set in order to derive a first approximation of the vegetation types of the area. Refinement of this classification was done by the application of Braun-Blanquet procedures (see also Behr & Bredenkamp 1988; Bredenkamp *et al.* 1989; Kooij *et al.* 1990b). The results are presented in a phytosociological table (Table 1). Soil properties for each community are given in Table 2.

Results

Classification

In general the vegetation of the B land type can be considered as a *Themeda triandra – Eragrostis curvula* grassland. The vegetation is generaly utilized as pasture for cattle and sheep. *Themeda triandra* is mostly the dominant species, however, in overgrazed or degraded situations *Eragrostis curvula* becomes dominant. Many

Table 1 A phytosociological table of the vegetation of the B land type of the north-western Orange Free State, South Africa

COMMUNITIES	1	2			3			4
		2.1	2.2	3.1	3.2		3.3	
RELEVES	10000000000 59113049535 62317804930	111010110 555151347 197930289	111010000100000101 780952399199994927 562742453061089768	001000011111 003201843089 131378009954	00101011100111111111110110101001111 02433222322222336678833668287556 79 45625186847794323007010622127891 5		000001111 041857665 944363788	01111101101 12 21671117112 50 01164254373 23
SPECIES GROUP A								
ERAGROSTIS PLANA	++ + 1 3+1	+ +		+			+	+ +
SCHKUHRIA PINNATA	+++ + ++	+ +	+	+ ++	+ +	+	+	+
CHLORIS VIRGATA	++++1+			+ + +	++ ++ ++		++	
SETARIA SPHACELATA	12 31 +		+ +	+ +	+ +		+ +	+ +
ARISTIDA BIPARTITA	++ 13	+ +						+
BRACHIARIA ERUCIFORMIS	1 + +	+ +						
SPECIES GROUP B								
OXALIS DEPRESSA	•	+++++++	+ +++++++ ++	+ +	+			+
MICROCHLOA CAFFRA		+ + ++ +	++ + + ++ +		+ + + +			
BERKHEYA RADULA	+ +	+ + ++	++ + + +				+ + ++	+
SPECIES GROUP C								
STACHYS SPATULA	+ + +	+	1++++ ++++++++++	+	+		+ +	+ +
CIRSIUM VULGARE	+ +	+	+++ ++ + +++++	+	+ + + + + +		++ +	+ +
STOEBE VULGARIS	+		+ 1 +++ 1++ +++	+	+ ++ + ++		+++	
SPOROBOLUS DISCOSPORUS		+	+++ ++ +	+	+ +		+	
BECIUM OBOVATUM	+		++ +					+
OENOTHERA ROSEA			+ + + + +		+			
LYCIUM CINEREUM			+++				+	
SPECIES GROUP D								
TRIRAPHIS ANDROPOGONOIDES	+ +	+ +	+ + +	++++++++ +	+ ++++ +++++ ++ + +		++ +	
LEDEBOURIA MARGINATA	+			++ +++++ +	++ + +++++++++ + ++ + +		+ +++	
BRACHIARIA SERRATA	+ +	+		++++	+ ++ ++++++ ++ ++ + ++ +++		+ + ++	
BARLERIA MACROSTEGIA	+	+	+ +	+ + + + ++	++ + + ++ +++ ++ + ++		+ +++	
TRAGUS BERTERONIANUS		+	+	++ ++ +	+ ++++ + 1 + + + +		+	
BULBINE NARCISSIFOLIA			+ + + ++	++ +	+ + + + +		++ +	
SPECIES GROUP E								
ACACIA KARROO	+ +	+	2 +	21+1++21++++	+ ++			+
PROTASPARAGUS LARICINUS	+		+	21++++21++				+
PROTASPARAGUS SUAVEOLENS	+			++++++1++				
ZIZIPHUS MUCRONATA				2++ +2++				+
ERAGROSTIS TRICHOPHORA			1	232	4 + +			
SPECIES GROUP F								
ERAGROSTIS LEHMANNIANA		+ +	+ 1	+ + +	+ 21 2+1 +3+ + + +++			
ANTHEPHORA PUBESCENS	+		+	1 + ++	+2+ +++ 2 + + +			
KYPHOCARPHA ANGUSTATA				+ + +++	+ + ++ +++ +++ +			
CUCUMIS AFRICANA	+	+ +	+	+++	++ ++ + + + +			+
TURBINA OBLONGATA				+ + +	+ + ++ + + ++			
ARISTIDA CANESCENS		+	+	1++ 1	++ + ++ +			
RHYNCHELYTRUM REPENS		+	+	+ +	+ ++ + + + + +			+

Table 1 Continued

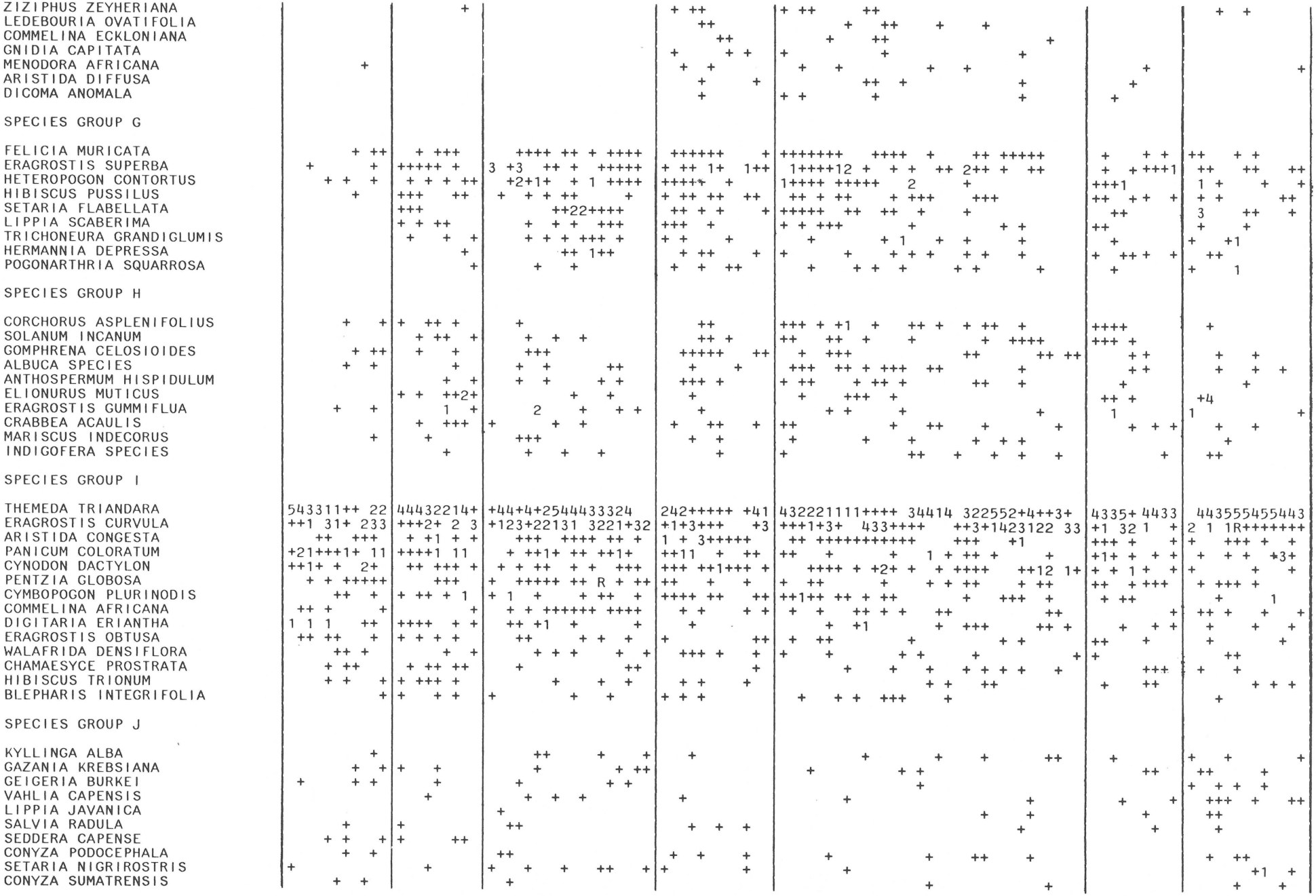
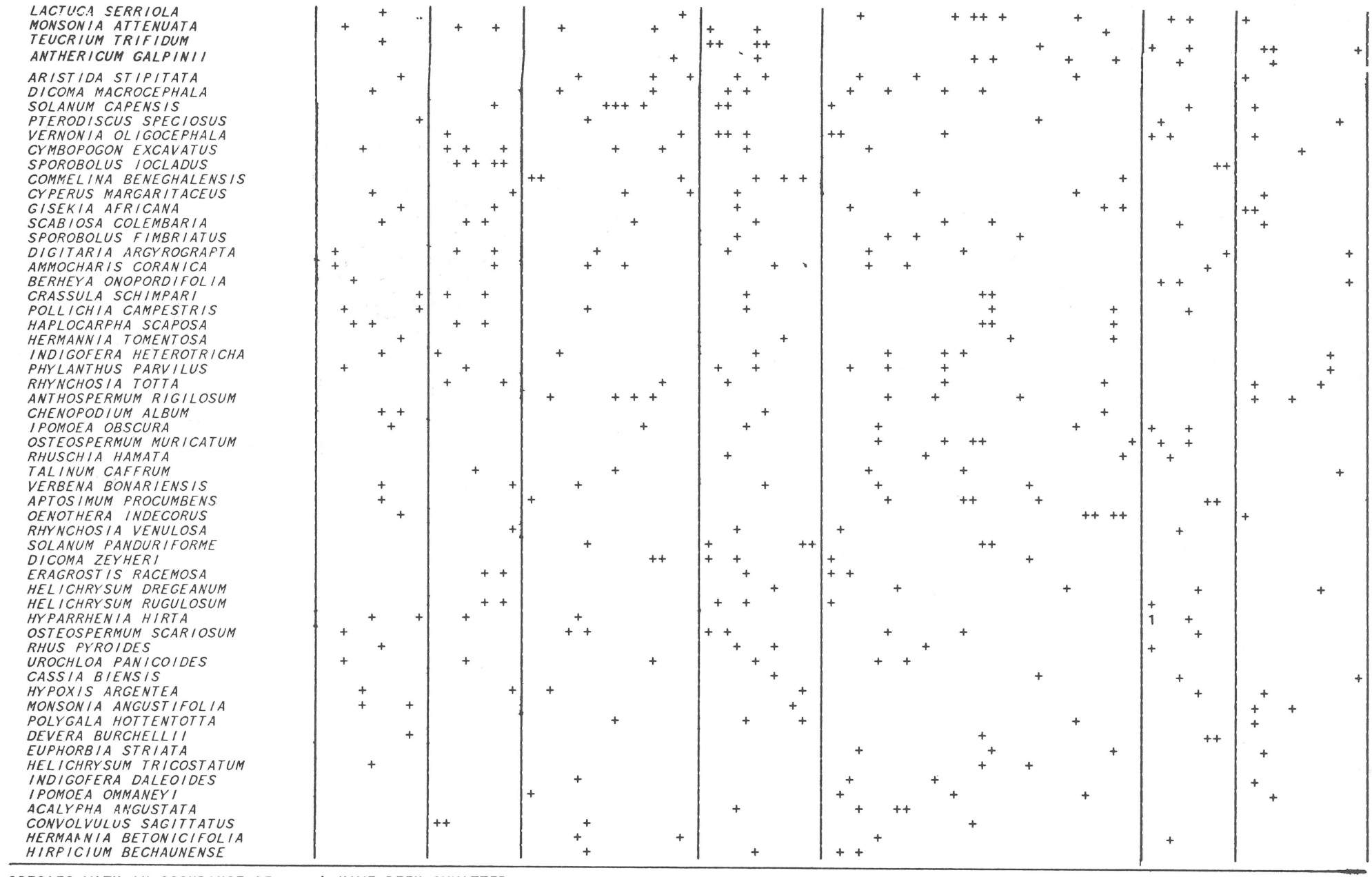


Table 1 Continued



SPECIES WITH AN OCCURANCE OF < 4 HAVE BEEN OMMITTED.

Table 2 An analysis of the soil properties of the A and B horizons of the plant communities in the B land type of the north-western Orange Free State (adapted from Land Type Survey Staff 1984)

Community number		1	2	3.1	3.2	3.3	4
Soil form		Bonheim	Swartland	Hutton	Clovely	Avalon	Sterkspruit
Soil series		Bonheim	Nyoka	Shorrocks	Blinkklip	Heidelberg	Stanford
Soil depth (mm)	A	0–310	0–230	0–280	0–150	0–350	0–180
	B	0–700	0–530	0–720	0–400	0–>1000	0–360
% sand	A	45	54	80	83	91	80
	B	31	38	69	77	83	69
% silt	A	13	7	1	5	3	1
	B	15	9	1	7	4	7
% clay	A	39	36	19	12	6	17
	B	49	51	31	17	15	24
H_2O retentivity (%)							
33 kPa	A	38.9	25.0	–	9.3	3.7	7.1
	B	41.2	37.6	24.0	13	8.0	25.9
1500 kPa	A	20.5	15.8	–	5.0	2.6	3.4
	B	23.3	23.7	12.7	6.7	4.9	12.9
Exchangeable cations (me kg^{-1} soil)							
Na	A	40	2	1	1	0	1
	B	45	9	2	1	4	32
K'	A	2	8	4	4	2	3
	B	2	4	3	4	6	2
Ca	A	110	83	62	18	14	20
	B	114	121	93	30	12	61
Mg	A	98	63	15	12	10	12
	B	134	129	26	18	11	58
Total	A	250	156	82	35	26	36
	B	285	263	124	53	33	153
pH (H_2O)	A	7.9	6.4	7.2	6.5	7.0	7.4
	B	8.1	6.9	6.9	6.5	6.7	9.1
Resistance (ohm)	A	280	1300	1300	2200	2400	2500
	B	120	700	600	1800	860	600

of the grass species of species group I (Table 1) are classified as increasers 2 and 3 (Bosch & van Rensburg 1987). These species increase, and are therefore abundantly present, in overgrazed or selectively grazed, degraded vegetation in the western Grassland Biome. The poor condition of these grasslands is emphasized by the presence of the karroid shrub *Pentzia globosa* and other pioneers such as *Aristida congesta, Cynodon dactylon, Eragrostis obtusa, Walafrida densiflora, Chamaesyce prostrata, Hibiscus trionum* and *Blepharis integrifolia*.

The number of species recorded per sample plot varies from 8 to 50 with an average number of 25. The plant communities distinguished in the study area can be classified in a hierarchy as follows.

1. The *Aristida bipartita – Eragrostis plana* Vlei Grassland of wet, seasonally waterlogged depressions and vleis.
2. *Berkeya radula – Microchloa caffra* Grassland of flat lowland peneplains and footslopes.
   2.1 *Stachys spatula* variant, representing a degraded phase of 2.
3. *Brachiaria serrata – Triraphis andropogonoides* Grassland of sandy upland areas.
   3.1. *Triraphis andropogonoides – Acacia karroo* Woodland of river valleys or on dolerite-derived soils.
   3.2. *Triraphis andropogonoides – Anthephora pubescens* Grassland of moderately deep, yellow, sandy, rocky soils.
   3.3 *Triraphis andropogonoides – Themeda triandra* Grassland of deep, yellow, sandy soils.
4. *Panicum coloratum – Themeda triandra* Grassland of footslopes with sandy clay loam soils, towards bottomland situations.

Description of the communities

1. The *Aristida bipartita – Eragrostis plana* Vlei Grassland

This grassland is restricted to seasonally wet depressions,

pans and vleis (terrain unit 5) of the Bd and to a lesser extent also the Bc land type (Figure 3). The clayey soils of the Rensburg, Willowbrook, Katspruit or Bonheim soil forms have a poor internal drainage regime and are therefore often waterlogged. Soil properties are given in Table 2. The vegetation is characterized by species group A (Table 1) and diagnostic species include the grasses *Eragrostis plana, Chloris virgata, Setaria sphacelata, Aristida bipartita, Brachiaria eruciformis* and the annual weed *Sckhuhria pinnata*. The vegetation is often overgrazed and trampled. An average of 20 species was recorded per sample plot. The absence of the generally widespread species of species groups G and H is also characteristic. The vegetation is mostly dominated by *Themeda triandra, Eragrostis curvula, Panicum coloratum, Setaria sphacelata, Eragrostis plana* and *Cynodon dactylon*, with the general species of species group I also present.

2. The *Berkheya radula – Microchloa caffra* Grassland

This grassland is found in the Bd and to a lesser extent in the Bc land type and is situated on the flat lowland peneplains (terrain unit 4, Figure 2) adjacent to vleis, pans, water courses and depressions (Figure 3). The clay–loam soils represent the Valsrivier, Swartland and Sterkspruit soil forms, but the Hutton and Avalon, or Bonheim forms may also occur in places. Soil properties are given in Table 2.

The vegetation is characterized by species group B (Table 1) with diagnostic species *Oxalis depressa, Microchloa caffra* and *Berkheya radula* and the absence of species group C (Table 1). An average of 25 species was

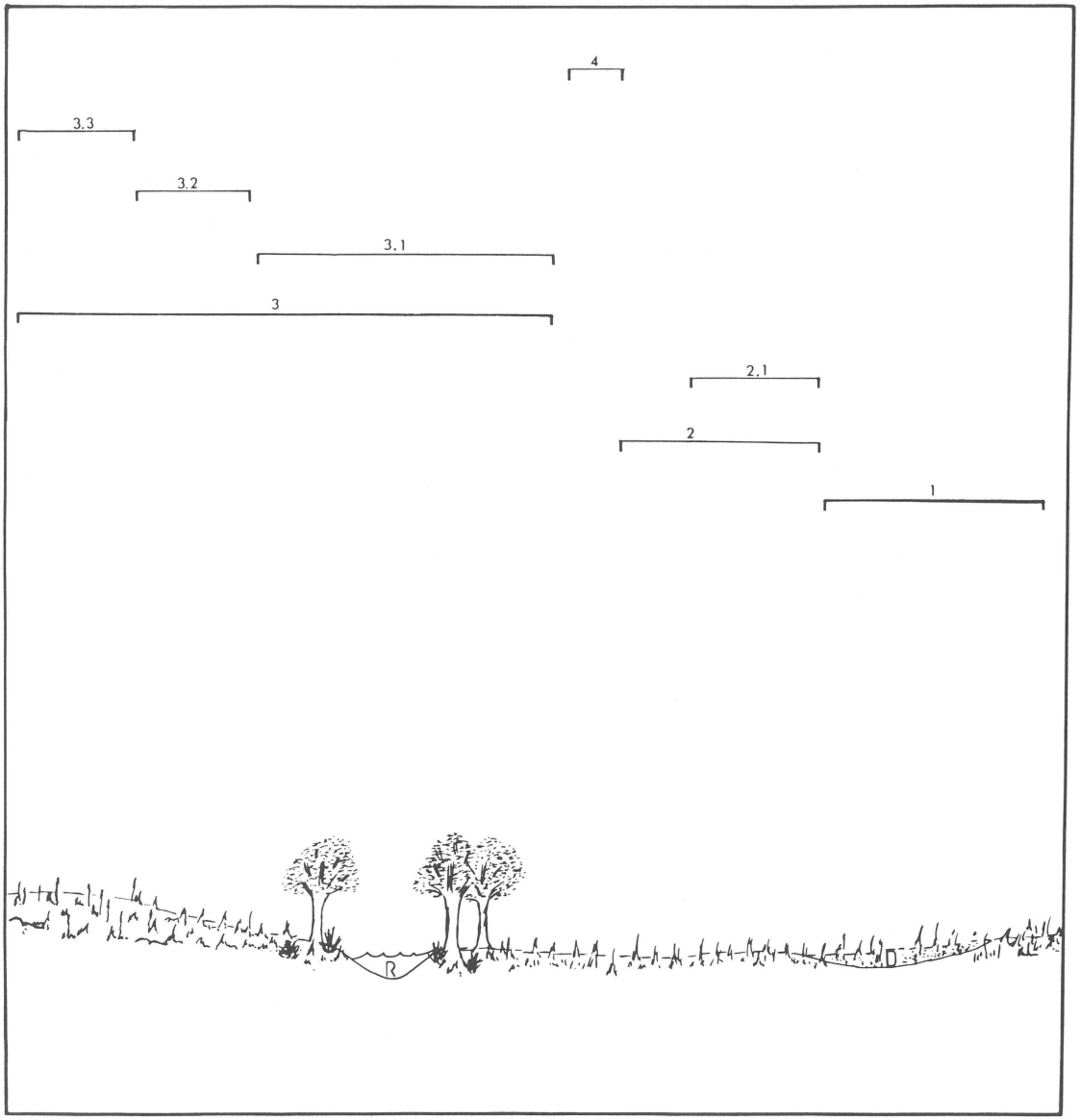


Figure 3 A schematic representation of the topographical gradient and vegetation of the Bd and Bc land types. Legend D — depressions; R — river; 1 — *Aristida bipartita – Eragrostis plana* Vlei Grassland; 2 — *Berkheya radula – Microchloa caffra* Grassland; 2.1 — *Stachys spatula*-variant; 3 — *Brachiaria serrata – Triraphis andropogonoides* Grassland; 3.1 — *Triraphis andropogonoides – Acacia karroo* Woodland; 3.2 — *Triraphis andropogonoides – Anthephora pubescens* Grassland; 3.3 — *Triraphis andropogonoides – Themeda triandra* Grassland; 4 — *Panicum coloratum – Themeda triandra* Grassland.

recorded per sample plot. The vegetation is entirely dominated by *Themeda triandra*, with *Eragrostis curvula* prominent in some degraded localities. Species of species groups G, H and I (Table 1) are usually present in this community. Other conspicuous and constantly present (>75%) species include the grasses *Eragrostis superba, Heteropogon contortus, Aristida congesta, Panicum coloratum* and *Cynodon dactylon* and the forbs *Felicia muricata* and *Pentzia globosa*.

2.1 The *Stachys spatula*-variant

This variant repesents an overgrazed and degraded variation of the *Berkeya radula – Microchloa caffra* Grassland. Although this vegetation occurs scattered throughout the range of the *Berkheya radula – Microchloa caffra* Grassland, it seems to predominate on slightly raised footslopes to midslopes (terrain unit 3–4) towards the upland situations in the undulating landscape (Figure 3). In this variant the diagnostic weedy species *Stachys spatula, Cirsium vulgare, Stoebe vulgaris* and *Sporobolus discosporus* have encroached the area and are prominently present, while *Eragrostis curvula* often attains relatively high cover values. Other diagnostic species are *Becium obovatum, Oenothera rosea* and *Lycium cinerium* (species group C, Table 1). An average of 24 species was recorded per sample plot.

3. The *Brachiaria serrata – Triraphis andropogonoides* Grassland

This major community occurs on sandy loam soils of upland situations on both the Bc and Bd land types. The community is represented by isolated relics of natural vegetation, as most of its habitat has been destroyed by ploughing for maize cultivation. The sandy soils are moderately deep, yellow to red sands, representing the Clovelly, Avalon, Westleigh, Hutton and Bainsvlei soil forms. However, where dolorite sills or diabase plates occur the soils are shallower, slightly more clayey and rocks or gravel may be found on the soil surface. Soil properties are given in Table 2. The vegetation is characterized by species group D (Table 1). Diagnostic species are the grasses *Triraphis andropogonoides, Brachiaria serrata* and *Tragus berteronianus*, the geophytes *Ledebouria marginata* and *Bulbine narcissifolia* and the forb *Barleria macrostegia*. Three distinct communities were identified.

3.1 Triraphis andropogonoides – Acacia karroo *Woodland*

This woodland mostly occurs on the gradual slopes towards the Vaal and Renoster River valleys (terrain unit 3, 4 and 5) (Figure 3) on moderately deep, reddish, sandy loam soils of the Hutton and Glenrosa soil forms. These soils are mostly derived from dolerite or diabase mainly on the Bc land type. The community is characterized by species group E (Table 1), which includes the diagnostic woody and semi-woody species *Acacia karroo, Protasparagus laricinus, Protasparagus suaveolens* and *Ziziphus mucronata*, and also the grass species *Eragrostis trichophora*. These areas are often severely overgrazed and here considerable increase of woody species has occured (see also Friedel 1987; Bredenkamp *et al.* 1989; Bredenkamp & Bezuidenhout 1990). In areas prone to bush encroachment the vegetation is dominated by the diagnostic woody species and the herbaceous layer is mostly poorly developed with patches of bare soil and considerable surface erosion. Despite the overgrazed nature of the vegetation, many species occur in this community and species groups D, E, F, G, H and I are present (Table 1). An average of 35 species was recorded per sample plot. In addition to the diagnostic species mentioned from species group 13, the following grass species are constantly (>50%) present *Themeda triandra, Eragrostis curvula, Aristida congesta, Panicum coloratum, Cynodon dactylon* and *Cymbopogon plurinodis*, and forbs such as *Hibiscus pusillus, Gomphrena celosioides* and the dwarf shrub *Felicia muricata*.

3.2 Triraphis andropogonoides – Anthephora pubescens *Grassland*

This grassland is typical for the moderately deep, yellow sands of the Avalon, Westleigh and Clovelly soil forms, found scattered throughout the vast area of the Bd land type and to a lesser extent in the Bc land type. Although the sands overlaying Karoo sediments may be deep and without gravel or rocks on the soil surface, shallower soils with gravel or rock overlaying dolorite sills can also be found in this community.

Although no diagnostic species group could be identified, the community can be distinguished by the simultaneous presence of species group D and F and the absence of species group E (Table 1). A floristic relationship between this grassland and the *Triraphis andropogonoides – Acacia karroo* Woodland is indicated by species group F. Species from species groups G, H and I (Table 1) are also present in this community. The only floristic difference between these two communities is the presence of mostly the woody and semi-woody species of species group E in the *Triraphis andropogonoides – Acacia karroo* Woodland. In the *Triraphis andropogonoides – Anthephora pubescens* Grassland the herbaceous layer is well developed, dominated by *Themeda triandra* and/or *Eragrostis curvula* with *Anthephora pubescens, Eragrostis lehmanniana* and *Eragrostis superba* locally prominent. An average of 33 species was recorded per sample plot. Other constantly present species (50%) include the grasses *Brachiaria serrata, Aristida congesta, Cynodon dactylon* the geophyte *Ledebouria marginata* and the dwarf shrub *Felicia muricata*.

3.3 Triraphis androrogonoides – Themeda triandra *Grassland*

This grassland community is found on the vast plains of the Bc and Bd land types on very deep, yellow, eolian sands of the Avalon and Clovelly soil forms. No diagnostic species group could be identified, but the community can be distinguised by the presence of species group D and the absence of species group F (Table 1). The vegetation is mostly well developed and is

in a good condition with *Themeda triandra* entirely dominant. On overgrazed sites *Eragrostis curvula* is also prominent.

This grassland is relatively poor in species composition, as is the case in many *Themeda triandra*-dominated communities. An average of only 23 species was recorded per sample plot. Other species constantly present (50%) include the grasses *Eragrostis superba, Triraphis andropogonoides, Aristida congesta, Panicum coloratum* and *Cynodon dactylon*, the forb *Hibiscus pusillus* and the karroid shrubs *Pentzia globosa* and *Felicia muricata*.

4. The *Panicum coloratum – Themeda triandra* Grassland

This community mostly occurs on the shallower sandy clay loam soils of footslopes towards bottomland situations (terrain unit 4) (Figure 3) in the Bc land type. Typical soils for these situations are of the Valsrivier, Sterkspruit or Westleigh forms. The community also occurs in isolated patches on deeper yellow sands in the Bd land type, but here the vegetation is degraded due to overgrazing. Soil properties are given in Table 2. This grassland is dominated by dense stands of *Themeda triandra* and is extremely poor in species composition. An average of only 18 species per sample plot was recorded. Only the general species (species group I) occur constantly in this community while species of species groups G and H are poorly represented.

Concluding remarks

The vegetation varies as a result of variations in habitat, for example topography, soil type, drainage regime and vegetation management (grazing by animals), and consequently various plant communities can be distinguished. The results of this phytosociological survey, together with the results of the phytosociological study of the vegetation of the D land types (Kooij *et al.* 1990b) form the basis for a phytosociological synthesis of the north-western Orange Free State. The plant communities distinguished by the application of TWINSPAN procedures refined by Braun-Blanquet procedures are considered as ecological interpretable as it can be related to specific environmental conditions.

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